THE POPULATION DENSITY AND STRUCTURE OF ASIAN ELEPHANTS IN PARAMBIKULAM WILDLIFE SANCTUARY, KERALA, INDIA[1]

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(*With three text-figures*)

Key words: Asian Elephant, *Elephas maximus,* Parambikulam Wildlife Sanctuary, population, biomass, density, group composition, solitary elephant

The population of Asian elephants in Parambikulam Wildlife Sanctuary, Kerala, India was studied during 1981-1983. The sanctuary with an area of about 270 sq. km has both natural forests and plantations. A total count indicated about 114 elephants with an ecological density of about 0.5 animal/sq. km. The biomass was about 905 kg/sq. km. The herd size frequency showed a polymodal distribution. The herd size of eleven was more frequent. The basic family unit in the population was around five. There was no significant seasonal or monthly differences in herd size. Forty three percent of the herds were without bulls. About 66% of the adult males observed were solitary. The sex ratio of 1:6.8 (male:female) indicates a slight increase in male mortality. The proportion of juveniles and calves (21%) indicates a high percentage of breeding females in the population.

INTRODUCTION

The populations of Asian elephant *(Elephas maximus)* in India have been affected adversely by a growing human population and the resultant destruction of natural habitat for settlement and cultivation. Poaching for tusks have also contributed to their depletion. The status of Asian elephants in India has been reviewed by Daniel (1980). However, apart from the studies conducted by Sukumar (1985), no detailed data have been published on Asian elephants in India.

The total number of an animal such as the elephant in an area is important because of its large contribution to the biomass with its limited numbers. Herd size and composition provide information on social organisation of the species, and are often related to environmental conditions (Leuthold and Leuthold 1975). Nair *et al.* (1985), Nair and Balasubramanyan (1985) and Easa and Balakrishnan (1990) describe number, herd composition and age structure of elephant populations in different sanctuaries of Kerala. The present paper deals with the number, herd composition and size and population structure of the Asian elephant in Parambikulam Wildlife Sanctuary, Kerala, during 1981-1983. This paper forms part of the detailed ecological study of the species in the area.

STUDY AREA

The Parambikulam Wildlife Sanctuary (76° 35' and 76° 50' E and 10° 20' and 10° 26' N) is 270 sq. km in area and is situated at an elevation of 600 m above sea level. It is contiguous on all sides with forests and includes three water reservoirs of about 28 sq. km area. The habitat includes tropical wet evergreen forests, moist deciduous forests, grasslands, swamps, and plantations of teak and eucalyptus.

The temperature in Parambikulam ranges from 13°C to 32°C. The average annual precipitation is 2590 mm. The area gets both the south-west and north-east monsoons. However, south west monsoon is more active in the region. The rainfall data of the area indicate two seasons — dry (January to May) and wet (June to December). A detailed description of the study area is given by Easa and Balakrishnan (1990).

METHODS

The study area was covered on foot every month during 1981-83. Herd size and composition

and population structure of herds encountered were noted by direct observation. A herd was defined by the criteria of Kurt (1974). Elephants were classified into different age groups as suggested by Eisenberg and Lockhart (1972). The height of individuals were assessed by the photogrammetric method to allow age determination (Laws 1966). A total count of elephants was made by Kerala State Forest Department in May, 1983. The study area was divided into fourteen blocks of almost equal size and each block was covered by a team of three investigators. All blocks were covered equally in one day on foot noting the number, sex and age group of elephants encountered. Results of this census was used only for total number and density of elephants within the sanctuary.

ANALYSES

The biomass of elephants within the sanctuary was calculated using an average weight of 1810 kg/ animal (Eisenberg and Lokhart 1972). A solitary elephant was considered as a herd for calculating herd size frequency. The monthly and seasonal variations in herd size were estimated by pooling the herd size data over months. Variances in herd size in each season was compared by F test. A student t-test was used for testing the difference between mean herd size for the two seasons, and one way ANOVA for the monthly data. The proportion of solitary elephants out of the total number of herds computed for different months and seasons were compared using X^2 test. A similar test was done for comparing the proportion of the loners in two seasons. Herd composition estimates were developed, excluding loners, based on all sightings (Cochran 1977) and monthly data. These were compared through a X^2 test and found to be non-significant (X^2 (5,0.05)=0.03 ns). Hence the population structure was derived based on all sightings. The standard error for population structure was calculated from multiple values obtained from blocks.

RESULTS

The count conducted in May, 1983 showed a total of 114 elephants in the Sanctuary. Of these, 55

(48%) were adult females, 35(31%) were adult males and 24(21%) juveniles and calves. The ecological density of the species in the area was about 0.5 animal/ sq. km. The biomass was about 905 kg/sq. km.

Herd Size Frequency: The herd size frequency shows a polymodal distribution with peaks occurring at 1, 5, 9 and 11 (Fig. 1). A strong tendency for herd sizes between 3 and 7 is evident, suggesting that the basic unit in the population could be around five.

There were no significant seasonal ($t_{89,0.05}$ = 0.97 ns) or monthly ($F_{(11,80)0.05}$ = 1.23 ns) differences in herd size, despite the large variation in monthly means (Fig. 2).

Solitary Elephants: Sixty six percent of the 35 adult males observed were solitary (Fig. 2). Only one lone adult female was seen. A single bull group with two tuskers was observed. There was no significant seasonal ($X^2_{(1,0.05)}$ = 0.81 ns) or monthly ($X^2_{11,0.005)}$ = 18.48 ns) variation in the proportion of solitary elephants in the population.
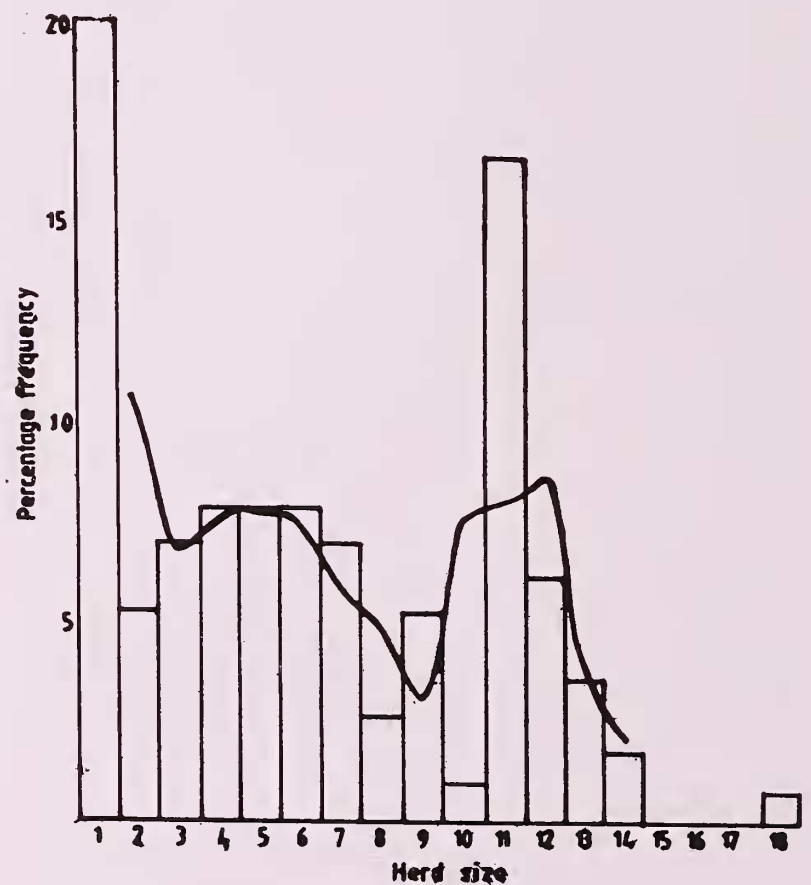

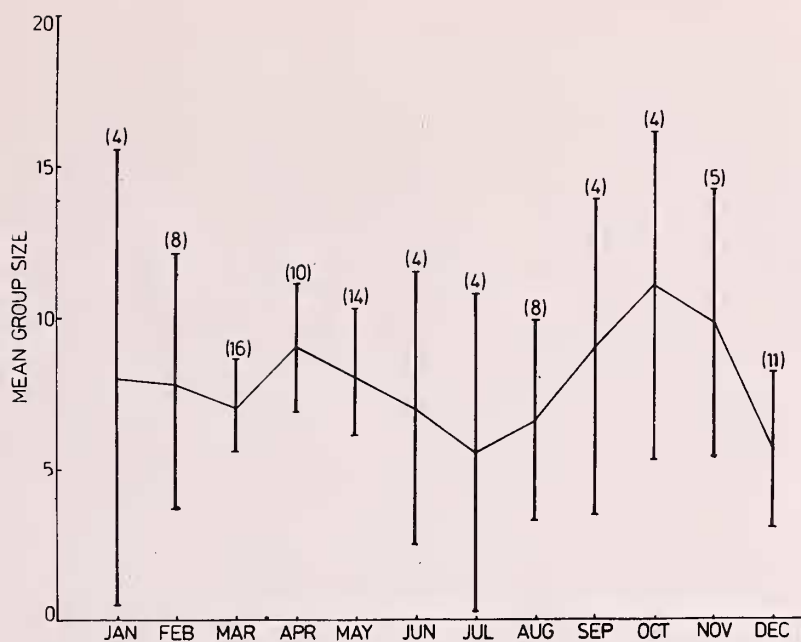Fig. 1. Percentage frequency distribution of group size of Asian elephants.

Fig. 2. Monthly mean group size of elephants with error bar.
The figures in parentheses denotes sample size.

Fig. 3. Percentage frequency distribution of age and sex classes
of elephant in the population.

Population Structure: The percentage frequency distribution of age and sex classes in the population is shown in Fig. 3. The sex ratios in the population with their standard errors are summarised in Table 1.

TABLE 1

SEX RATIO IN THE ELEPHANT POPULATION IN
PARAMBIKULAM WILDLIFE SANCTUARY,
KERALA

Age Classes and Sex	Ratio	SE
Adult female/Adult male	6.825	1.27392
Sub-adult female/Sub-adult male	1.913	0.47744
Adult female/Calf	3.102	0.22153
Adult female/Juvenile	2.007	0.12908
Females/Males	5.032	0.75620
Adult male/Sub-adult male	1.739	0.44672
Adult female/Sub-adult female	6.205	1.19687

DISCUSSION

The results of 1983 census show that the number of elephants in Parambikulam have increased by about 27% since 1981 (Balakrishnan and Easa 1986) with a 45% increase in females and 9% in males. However, the increase could be due to the seasonal movements of elephants from adjoining areas, especially Indira Gandhi Wildlife Sanctuary, during the dry season due to the presence of three reservoirs in Parambikulam Wildlife Sanctuary.
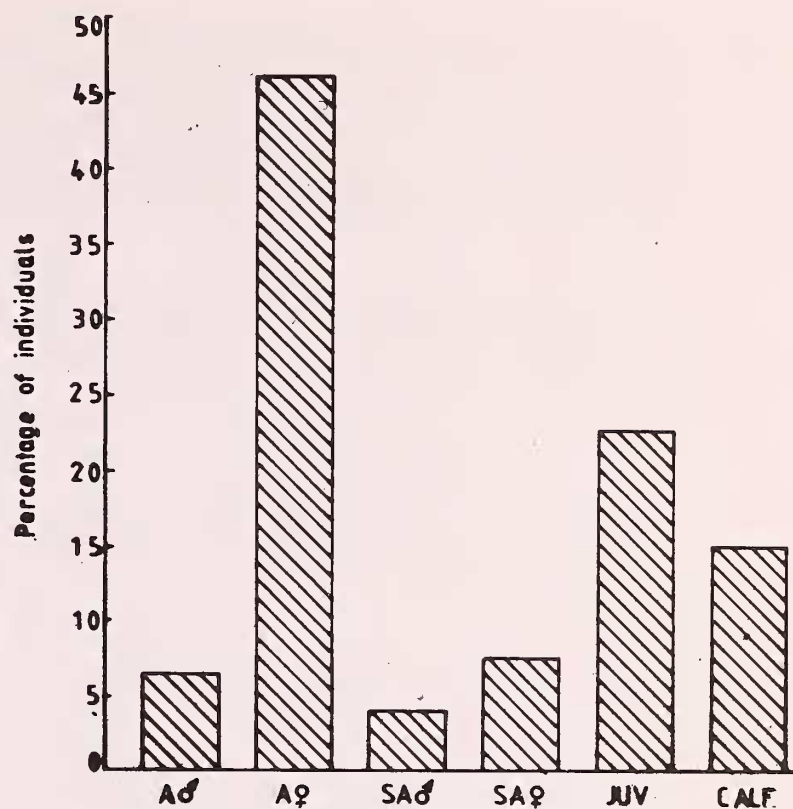
Easa (1989) has observed that the summer home ranges of elephant herds appear to be around the reservoirs within Parambikulam. At the onset of rains, the herds extend their ranges to the Indira Gandhi Wildlife Sanctuary. Still, a slight increase in the population cannot be ruled out as evident from the percentage of juveniles and calves (21%) in the population.

The density of elephant in Parambikulam is higher than for other Asian elephant habitats (Eisenberg and Lockhart 1972, Olivier 1978, Ishwaran 1984 and Santiapillai *et al.* 1984). However, this represents a seasonal peak. Eisenberg and Seidensticker (1976) have opined that in suitable south east Asian habitats, density of elephants could range from 0.1 to 1.0/sq. km. Considering the contiguity of elephant populated habitat in areas adjacent to Parambikulam, the density could be much lower than obtained.

Nair *et al.* (1985), Sukumar (1985) and Olivier (1978) obtained polymodal distributions of herd size frequency. Olivier (1978) concluded that the basic family unit was six individuals. The smaller herd size more frequent in our population

might be due to the comparatively forested habitat in the area (Peek *et al.* 1974, Leuthold 1976). The herd size of eleven frequent in our population indicates both generation overlap and extended family units (Eisenberg and Lockhart 1972).

The large differences between monthly means of herd size appears to disagree with the findings of Leuthold (1976) and Rodgers (1976) and may be due to the environmental factors, such as heavy rainfall in June-July, changing the stage of vegetation favouring aggregations of smaller units (Douglas-Hamilton 1972).

Male elephants seen on their own at one time were later seen with a herd for a short period of time. Many herds (43%) observed were without bulls. McKay (1973) and Sukumar (1985) reported 60% and 23% of herds respectively without bulls. McKay (1973) reported that the association of males with the herds lasted only for a few days. The proportion of solitary elephants does not vary in relation to season or month suggesting a constant proportion of adult bulls in association with the herds throughout the year. Considering this and the shorter period of time spent by any male with the herd, it could be seen that the possibility of outbreeding is enhanced.

Assuming an equal sex ratio at birth, it appears that there was a higher mortality of males creating an adult sex ratio biased towards females. However, Sukumar (1985) considering 17.5 years as age of first conception and 4.7 years as mean calving interval, has shown by simulation that a medium male — medium female mortality could stabilize the ratio at 1:5.7. The adult sex ratio of 1:6.8 in the present population indicates a slight increase in the male mortality. The lesser disparity in the percentage of sub-adult females and sub-adult males indicates a decrease in recruitment to the population during a particular period of time and could produce delayed effects on population growth. However, the percentage of juveniles and calves is an indication of nullification of such an effect in the immediate future. The proportion of juveniles and calves in relation to the adult females is an indicator of a high percentage of females breeding in the population. However, further studies, on the age of first conception and the mean calving interval, would be required to assess the trend in the population.

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